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DYSART DRAIN IMPROVEMENT PROJECT

90% PLANS SUBMITTAL
DESIGN REPORT

NBS LOWRY

ENGINEERS & PLANNERS

DYSART DRAIN IMPROVEMENT PROJECT

90% PLANS SUBMITTAL
DESIGN REPORT

Prepared For:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
AND
LUKE AIR FORCE BASE

Registered Professional Engineer (Civil)
CERTIFICATE NO.
21684
BRIAN J.
FRY
Date Signed 9-20-94
ARIZONA, U.S.A.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
10512
ASHOK C.
PATEL
Date Signed 9/20/94
ARIZONA, U.S.A.

Prepared By:

NBS/LOWRY, ENGINEERS & PLANNERS
2600 North 44th Street, Suite 200
Phoenix, Arizona 85008
(602) 468-1688

WOOD/PATEL ASSOCIATES, INC
1550 East Missouri, Suite 203
Phoenix, Arizona 85014
(602) 234-1344

SEPTEMBER, 1994

DYSART DRAIN IMPROVEMENTS PROJECT
DESIGN REPORT

DYSART DRAIN IMPROVEMENT PROJECT
DESIGN REPORT

1.0 INTRODUCTION

1.1 Overview

This design report is prepared for the Flood Control District of Maricopa County, Arizona and the United States Department of Defense, Luke Air Force Base as part of the design of the Dysart Drain Improvements Project located in Maricopa County, Arizona. The Project Location is shown on **Figure 1**.

Preliminary Design of the Dysart Drain improvements is presented in Dysart Drain Improvement Project, Concept Design Study Selected Alternative, August 4, 1993 and Addendum dated November, 1993, prepared by The WLB Group, Inc. for the Flood Control District of Maricopa County.

The Dysart Drain Improvement Project consists of approximately four miles of concrete lined channel improvements, construction of a 160 acre detention facility with a one half mile collector channel, demolition and replacement of three bridges, box culverts, utility relocations, and related roadway improvements to protect the Luke Air Force Base from flooding for flood events up to the 100-year flood event. The project is designed to accommodate anticipated future subsidence for a 40 year horizon and still provide 100-year flood protection.

As part of the preparation of first draft preliminary plans, bridge alternatives and channel cross-section, profile, and alignment alternatives were developed and evaluated to refine the preliminary design presented in the Concept Design Study. The results and recommendations are contained in Dysart Drain Improvement Project, Alternatives Analysis Report, January 31, 1994, prepared by NBS/Lowry, which presents the alternatives evaluated along with design recommendations and preliminary costs.

Following selection of the preferred alternatives, and review of the preliminary design plans, the preferred alternatives elements were developed in further detail and are presented on the 90% plans. This design report presents the supporting documentation and calculations for the 90% design plans submitted under separate cover.

1.2 Acknowledgements

The NBS/Lowry and Wood/Patel team is pleased to participate in the Dysart Drain Improvement Project. NBS/Lowry was the prime consultant and Wood\Patel was a subconsultant responsible for project survey and right-of-way and design of the detention basin. Development of this report and design has presented many interesting and unique challenges requiring creative solutions.

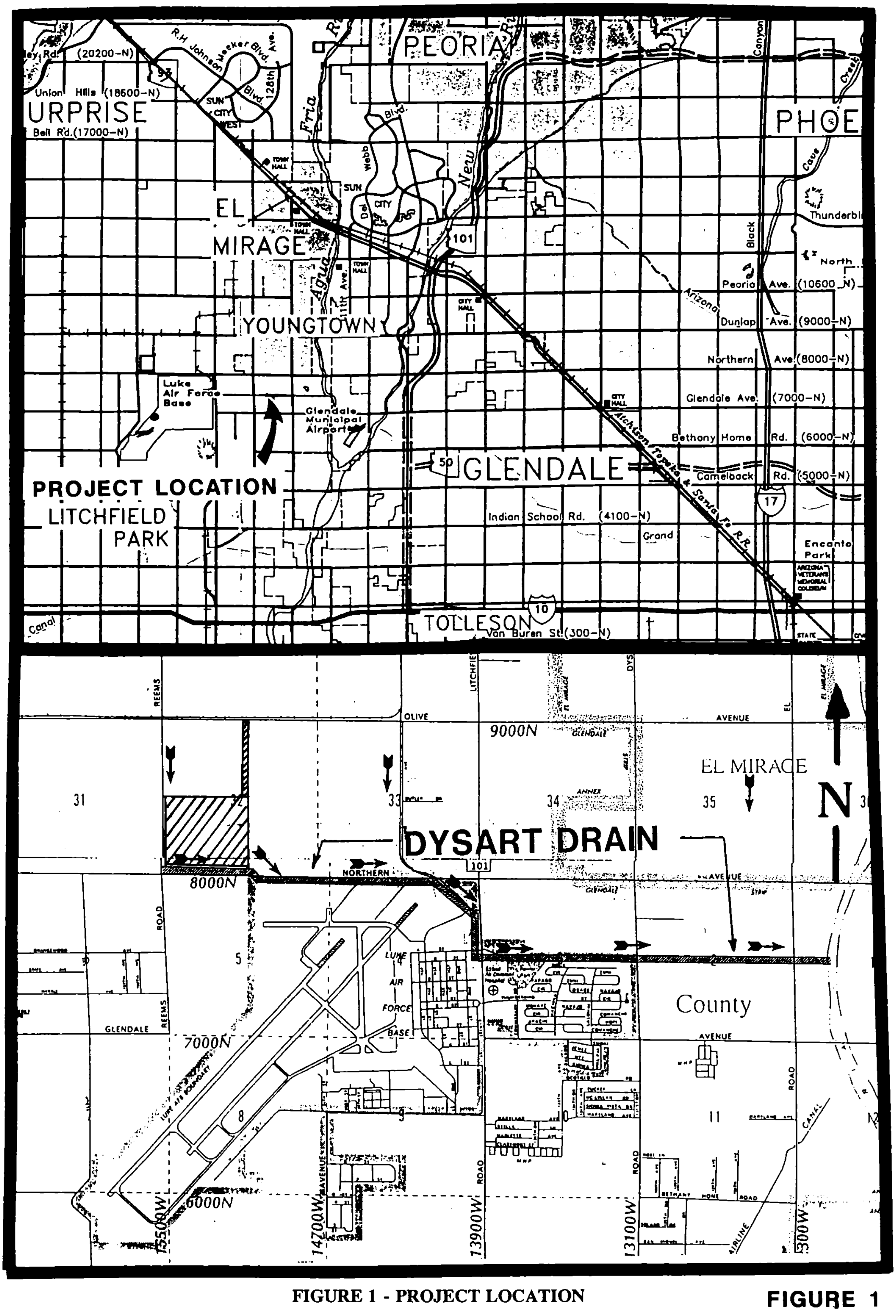


FIGURE 1 - PROJECT LOCATION

FIGURE 1

Mr. Don Rerick of the Flood Control District of Maricopa County and Mr. Zane Hoit, P.E. of the Luke Air Force Base provided critical technical support and decision-making guidance throughout the project. They made themselves available with short notice to discuss the project progress and potential solutions to problems as they were encountered. Their contributions represent a key role in the successful and timely completion of this project.

Further team support was obtained from Mr. Ken Ricker, P.E. and Mr. Ken Walsh, P.E., PhD. of Huntingdon Engineering and Environmental, Inc. for geotechnical support and Mr. Oscar Oliden, P.E. of Alpha Engineering Group for bridge and structural design.

We Sincerely enjoyed these relationships throughout the completion of this exciting project.

Brian J. Fry, P.E.
NBS/Lowry, Engineers & Planners

Ashok C. Patel, P.E.
Wood/Patel & Associates, Inc.

2.0 FIELD SURVEY AND RIGHT-OF-WAY

2.1 Field Survey

The topo survey, in digital format (AutoCAD), was furnished by the District for the channel alignment from the Agua Fria River to the detention basin outfall at Northern Avenue. Supplemental topographic data was surveyed to obtain adequate design detail as follows:

1. Field data for the channel bottom in the sag area east of Litchfield Road.
2. Detailed survey information on utilities and other features on several site-specific areas.
3. Topographic data using aerial photogrammetry by Aerial Mapping Company, Inc. for the 160-acre detention basin site.
4. Field cross-sectioning of the basin site to insure that the aerial topography meets accuracy standards.
5. Detailed field survey for the Reems Road alignment along the west boundary of the basin.
6. Detailed field survey for the East Collector Channel alignment.

Horizontal and vertical control for this project was prepared by The WLB Group and was furnished by the District.

Horizontal control is based on State Plane Coordinate System of 1927; and vertical control is based on NGVD 1929 datum.

2.2 Right-of-Way

Right-of-way data was provided by the District for the entire project. It was field confirmed by tying several control points of the alignment by the Wood/Patel survey crew.

All work was performed based on the section survey data provided by the District.

The right-of-way was calculated for the 160-acre basin site and the East Collector channel also from the District's furnished data.

3.0 UTILITIES

This section provides information on the location of utilities in the vicinity of the Dysart Drain Improvement Project. The locations of known conflicting utilities have been identified. In some cases, underground utilities were located by potholing.

3.1 Ownership

The following utility companies own utilities within the project corridor.

Owner	Facility
Santa Fe Pacific Pipeline Partners, L.P.	6-inch high pressure refined petroleum products pipeline.
Arizona Public Service Company	El Mirage Rd - 12kV overhead lines Dysart Rd - 69kV & 12KV overhead lines Litchfield Rd to E. of Dysart Rd - 69kV & 12Kv overhead lines. Northern Ave - 12kV overhead lines
Insight CableVision	Attached to APS poles along Dysart Rd.
Southwest Gas Corporation	Litchfield Rd - 6-inch high pressure gas main attached to bridge
US West Communications	Overhead Telco at El Mirage Road
Amerigas	Dysart Road - 6" high pressure gas line
Morton Salt Company	Utilities in steel carrier pipes crossing channel
Luke Air Force Base (Private Utilities)	Communication - Litchfield Rd to Dysart Rd & on base. 2" gas line on base Effluent reuse line - Litchfield to El Mirage Rd Sanitary sewer - at kennel and crossing channel at on base bridge Water line - crosses through channel on base Monitoring well Misc water lines & hydrants on base

In addition to the above, farm irrigation utilities are also impacted by the project. Mr. John Roach owns farmland from the mid-section line west of Dysart Road to the east side of the Morton Salt facility. Greer Farms owns the property adjacent to the detention basin. And Mr. Leyton Woolf owns the property adjacent to the East collector channel. Irrigation facilities impacting these farm operations will be relocated as described in the following section.

3.2 Relocations

The Santa Fe Pacific 6-inch jet fuel line will be relocated at the channel crossing at Dysart Road. The pipeline will be temporarily relocated east of the Dysart Road bridge as part of construction of the Dysart Road improvements for Maricopa County Department of Transportation. Following construction of the Dysart Road bridge with this project, the jet fuel line will be relocated to hang from the new bridge.

An Arizona Public Service Company (APS) utility pole at the northeast corner of the Dysart Road bridge will be relocated to avoid a conflict with the new bridge. As a result of the relocation, a new pole will be added south of the bridge. The Insight cable lines are suspended from the APS poles along Dysart Road and will be relocated to accommodate the APS relocation. The APS poles along the north side of the channel between Litchfield Road and Dysart Road will be braced to avoid relocation.

The Morton Salt utilities in the 24 inch steel carrier pipes will be relocated into new carrier pipes constructed to span the new channel. The carrier pipes will be relocated as part of the project and Morton Salt is responsible to relocate their own utilities.

The effluent reuse line will be relocated from east of the Morton Salt facility to El Mirage Road to accommodate the channel excavation. The reuse line will also be relocated west of Dysart Road to accommodate the invert access ramp.

A water line passes through the existing channel on the base at approximately station 142+50. The base will relocate the waterline prior to channel construction. A sanitary sewer line passes through the existing channel on base at the bridge near station 139. The sewer line is abandoned and will be removed by Luke personnel prior to channel construction.

Two sumps that collect tailwater flows from the Dysart Drain will be relocated for Mr. John Roach along with appurtenant piping.

An irrigation tailwater pumpback line and various concrete lined irrigation ditches will be relocated for Greer Farms to restore the farm operation that is disrupted by the project.

An irrigation tailwater pumpback line and various concrete lined irrigation ditches will also be relocated for Mr. Leyton Woolf to restore his farm operation that is disrupted by the project.

4.0 GEOTECHNICAL DATA AND SOILS

4.1 Field Investigation

The field investigation included a site reconnaissance, subsurface exploration, and field percolation testing. The subsurface exploration consisted of drilling 46 test borings at locations throughout the project. The test borings were drilled with a CME-75 drill rig using 7-inch diameter hollow stem augers. The test borings were drilled to depths ranging from 10 to 80 feet. Standard Penetration Test (SPT) sampling and 2.42-inch ring-lined driven soil sampling was performed in all borings, alternating at 5-foot intervals, to obtain an indication of the relative density and/or consistency of the formation being penetrated and to obtain samples for laboratory testing. Previous test borings, performed by Speedie and Associates for the interim repairs were also utilized. New test borings adjacent to Speedie and Associates test borings were only sampled below the deepest penetration of the previous test borings. In addition, bulk samples were obtained from the auger cuttings. Seven shallow subgrade samples were obtained in proposed pavement reconstruction areas. Percolation tests were conducted in three test borings in the proposed detention basin area at depths of 12, 14, and 16 feet, respectively.

During the field investigation, the soils encountered were visually classified by the field engineer. The results of the test drilling conducted for this project are presented on the boring logs in Report for Geotechnical Engineering Services, Dysart Drain Improvements Project, January 28, 1994, Appendix A, "Field Results".

4.2 Laboratory Investigation

Laboratory testing was conducted on representative soil samples obtained during the test drilling. The testing was conducted to obtain the data necessary to develop design recommendations for this project. The following tests were conducted:

Test	Sample(s)	Purpose
Sieve Analysis & Atterberg Limits	Representative (30)	Classification and correlation of engineering properties
Dry density and Moisture Content	Undisturbed (104) Disturbed (114)*	In-situ density and moisture determination to correlate engineering properties
Direct Shear	Undisturbed (13)	Bearing capacity, drilled shaft capacity, and slope stability analysis
Consolidation	Undisturbed (5)	Settlement analyses
Soluble Salts, Sulfates and Chlorides	Representative (4)	Corrosion potential

pH and Resistivity	Representative (4)	Corrosion potential
ASTM D698	Representative Grab Sample (6)	Compaction characteristics
R-value	Representative Grab Sample (4)	Pavement design
Expansion	Compacted (10) Undisturbed (1)	Expansion potential

* Disturbed samples from SPT sampling tested for moisture content only.

The results of the laboratory testing are presented in Report for Geotechnical Engineering Services, Dysart Drain Improvements Project, January 28, 1994.

4.3 Soil Conditions

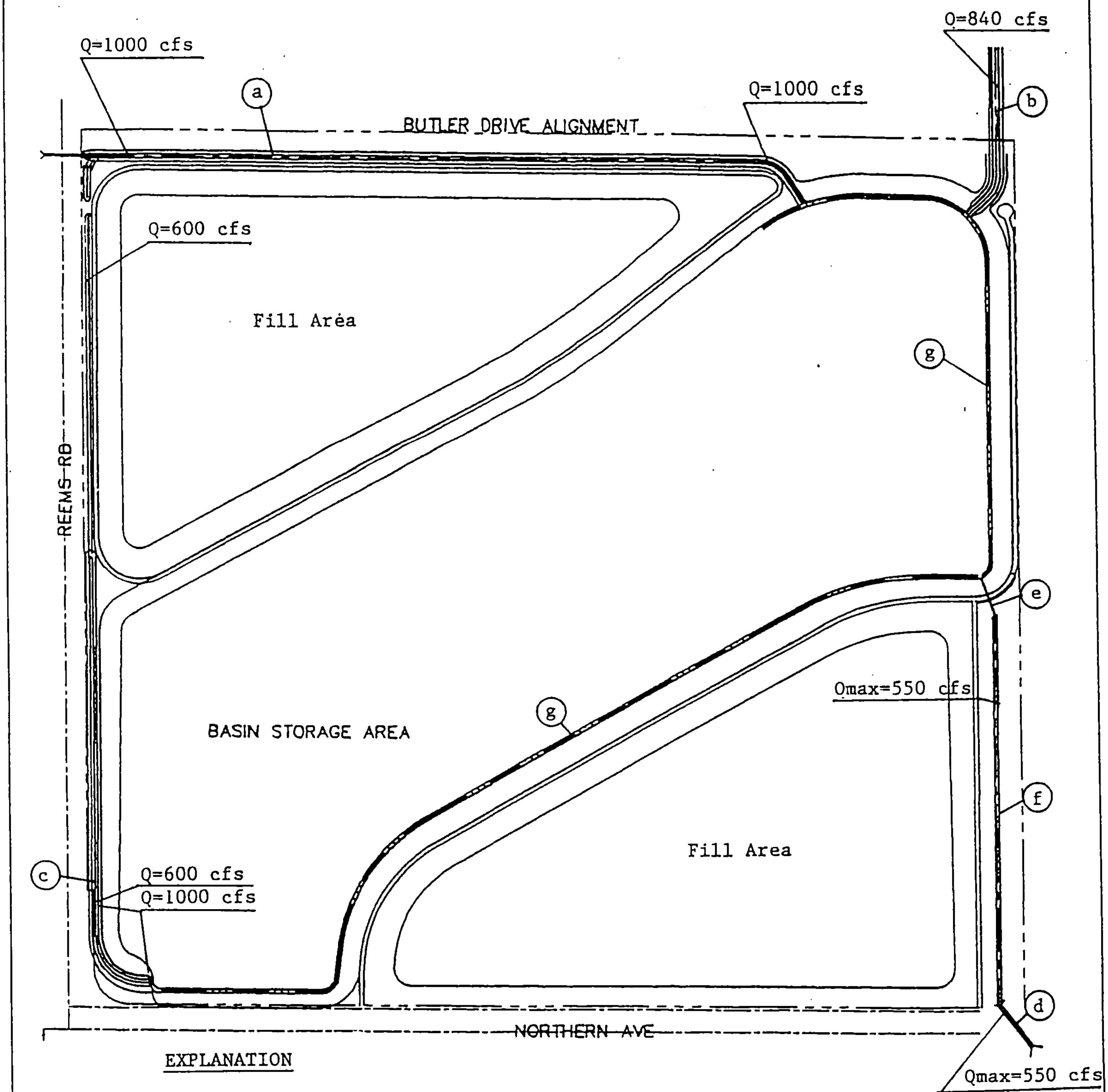
The soils encountered along the proposed channel alignment generally consisted of interbedded, stratified sandy clays and silty sands. The clay materials are generally stiff to hard, although thin, very hard cemented zones were encountered in some areas typically below a depth of 10 to 15 feet. The plasticity of the clays ranged from low to high. Low plasticity clays were common at the surface and the western portion of the alignment. High plasticity clays were encountered along much of the center portion of the alignment, typically in a 5 to 10 feet thick zone about 20 feet below ground. Seams or layers of clean to silty subangular to subrounded sands with gravels were observed in scattered locations in the test borings, ranging from a few inches to a few feet in thickness. The sandy soils became much coarser and continuous east of El Mirage Road and were generally dense to very dense with some zones containing cobbles in the vicinity of the Agua Fria River. Some test borings in the channel bottom inside Luke Air Force Base encountered clean medium to coarse sands in the upper six to twelve inches. Soil moisture conditions generally ranged from damp to moist, and no free groundwater was encountered in the test borings during drilling. Groundwater conditions may vary with time, seasonal conditions, and/or flow in the drain or the Agua Fria River. Graphical boring logs for all test borings are presented in the report.

The drainage channel crosses an active earth fissure area on the east side of the Morton Salt Facility. The existing lined channel in this area shows some cracking but no holes, voids or large cracks exist in the channel lining nor have any been reported in the past.

5.0 HYDROLOGY

For the purpose of design, NBS/ Lowry - Wood/Patel used the hydrology information provided by the District from the report titled Addendum to Dysart Drain Improvement Project, Concept Design Study Selected Alternative, November, 1993, prepared by WLB Group, Inc. The HEC-1 computer model provided by the District (updated December, 1993) was used to verify detention basin parameters and outflow requirements. Wood/Patel took the HEC-1 model and replaced the storage-outflow rating curves for the detention basin from the WLB report. The storage outflow rating curves are based upon the selected concept by Wood/Patel. All key drainage features for the selected concept are depicted on **Figure 2**.

The hydrology peak flows have been checked along the channel alignment as summarized on **Figure 3**. These values have also been approved by District staff.



EXPLANATION

a North Collector Channel
b East Collector Channel
c Reems Road Collector Channel
d Northern Avenue Box Culvert
e Basin Outlet Box Culvert
f Outfall Channel
g Nuisance Flow Swale

DRAINAGE FEATURES & DESIGN FLOWS

KEY MAP

WOOD/PATEL ASSOCIATES
Civil Engineers
Hydrologists
Land Surveyors
(602) 234-1344

Scale 1"=400' ±

FIGURE 2

Summary of Design (100-Year) Peak Flows (cfs) at Various Concentration Points

Dysart Drain Improvement Project

	Det. Vol. Needed	Basin Highwater Elev.	Basin Outflow	11193	CP194	CP195	D195	CP196	D196	CP202	CP204	CP205	CP206
Model dated December 8, 1993, by WLB with designed 160-acre basin in place	407.9 ac. ft.	1099.9	446	596	448	1772	1772	2300	2300	2287	3984	3979	3978

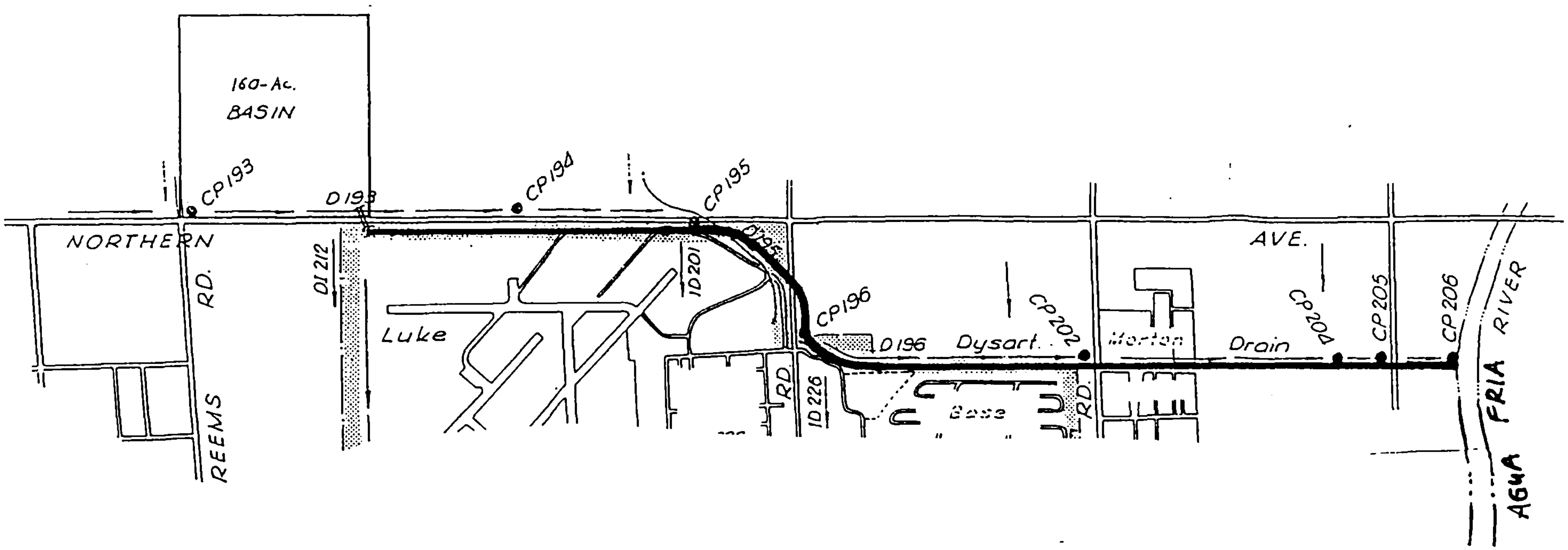


FIGURE 3

6.0 CHANNEL DESIGN

6.1 Design Criteria

Channel design is performed in accordance with the Drainage Design Manual for Maricopa County, Volume II, Hydraulics. The Dysart Drain Improvements are designed for the as constructed condition and analyzed for the future subsided condition to ensure performance during a 100 year storm event. The channel design criteria used for the Dysart Drain are summarized as follows:

Flow Conditions

Froude numbers for subcritical channel flow are to be less than or equal to 0.86. Froude numbers for supercritical flow are to be greater than or equal to 1.13 but less than 2.0. A minimum channel velocity of 2.0 feet per second is required to prevent deposition of fine sediments.

Channel Curvature

Changes in horizontal channel alignment are made with curves having a minimum radius of 3.0 times the water surface topwidth.

Freeboard

According to the Hydraulics Manual a minimum freeboard of 0.25 times the sum of the flow depth and velocity head is required, or a minimum of 1 foot for subcritical flow and 2 feet for supercritical flow, whichever is greater. In addition to the freeboard requirement from the Hydraulics Manual, the FEMA minimum freeboard criteria of 3 feet is provided where the channel lining is constructed on berms where the 100 year water surface elevation is above the adjacent natural ground.

Exceptions to the minimum freeboard requirement have been approved where surface runoff is required to flow into the channel via side spillways along the north side to prevent upstream ponding. The spillway elevation is set based on the adjacent ground elevation regardless of whether the freeboard criteria is met. The extent of lining without the required freeboard is limited by designing spillway sections to accept the side inflows. The channel lining beyond the limits of the spillways provides the minimum required freeboard.

The channel is designed to meet the freeboard criteria in the as constructed condition. The subsided condition is also checked and the channel lining extended to ensure that the 100 year discharge is contained within the channel lining with no freeboard requirement.

Channel Lining

The concrete channel lining is designed according to ADOT Channel Lining Design Guidelines, February 1989, the existing channel lining design, and the recommendations from the Report for Geotechnical Engineering Services, Dysart Drain Improvements Project, January 28, 1994 by Huntingdon Engineering and Environmental, Inc.

6.2 Channel Alignment & Profile

The channel alignment basically follows the existing channel alignment. The centerline is shifted slightly throughout the reach to accommodate the controlling design features and existing right-of-way. Controlling design features that govern the alignment are as follows.

1. The existing outfall structure at the Agua Fria River will be salvaged and incorporated into the channel design to minimize construction and permanent impacts to Waters of The U.S..

2. The Morton Salt facility has salt ponds adjacent and very close to the channel right-of-way. The channel is aligned to fit within the existing right-of-way at Morton Salt to minimize impacts to the salt ponds.

3. Between Litchfield Road and Dysart Road there are large 69 KV power lines along the north side of the existing channel. There is a new block wall along the south side of the channel. The new channel alignment was designed to fit between these two features. The 69 KV power poles will be within the channel cut slopes above the liner and will be braced to avoid relocation.

4. The new channel joins the existing channel east of Litchfield Road. The existing channel is utilized from east of Litchfield Road to the long box culvert on Luke Air Force Base. The existing channel lining is extended to achieve the required capacity and freeboard.

5. From west of the long box, the channel fits within a corridor bounded on the north by the Luke Air Force Base property line and Northern Avenue and on the south by the existing base access road. Base access road relocation is kept to a minimum.

The channel profile is characterized by deep cuts between the outfall at the Agua Fria River and a point west of Dysart Road. The deep cuts are required to overcome the effects of existing and anticipated subsidence. The maximum cut of approximately 30 feet is in the vicinity of the Morton Salt Bridge. From west of Dysart Road to near the end of the channel at the detention basin outfall, the channel lining extends above existing ground to achieve the required capacity and freeboard. The profile in this area is dictated by the existing channel profile which is to be salvaged and extended.

6.3 Reach Characteristics

Typical Section

The typical section has been developed with consideration for channel structural requirements with a concern for preventing hydrostatic pressure buildup and runoff flowing over unprotected cut slopes, maintenance concerns for access and weed control, right-of-way requirements, and utility conflicts.

In general, the typical section consists of a trapezoidal reinforced concrete channel with a four inch depression at the centerline and cutoffs at the top of liner. A minimum four foot bench is provided at the top of liner graded to provide a swale to keep surface flows at the top of liner away from the top of channel lip. The bench and swale allows relief of hydrostatic pressures potentially developing above the channel liner and prevents longitudinal flows at the top of liner from undermining the liner. Maintenance access roads are provided on both sides of the channel, except at the Morton Salt facility, where a maintenance access road is provided on the south side only. The south maintenance access road is located at the top of liner and the north access road is located at the top of the cut slope. Large cut slopes are protected with gravel mulch except at the Morton Salt facility where shotcrete is used. Smaller cut slopes are unprotected. The north maintenance access road, located at the top of slope, is graded away from the top of slope with a graded swale on the north side to intercept surface flows and prevent them from flowing over the cut slope. Intercepted flows are conveyed to spillways and discharged into the channel. Surface flows from the top of cut slope on the south side generally flow away from the channel eliminating the concern for flows passing over the slope. The typical channel section is shown on **Figure 4**.

Side Inflows

Side inflows enter the channel via irrigation tailwater pipes and channels, stormdrains, and side spillways. Existing irrigation tailwater pipes and channels are extended or cut back to match the new channel lining. Stormdrains are accommodated in a similar fashion. Stormdrain stubouts are provided in two locations to accommodate future Luke Air Force Base housing stormdrains. Pipes and channels are beveled to match the channel sideslope except where flap gates are provided in which case the flap gates are recessed into the lining to prevent obstructions to the flow.

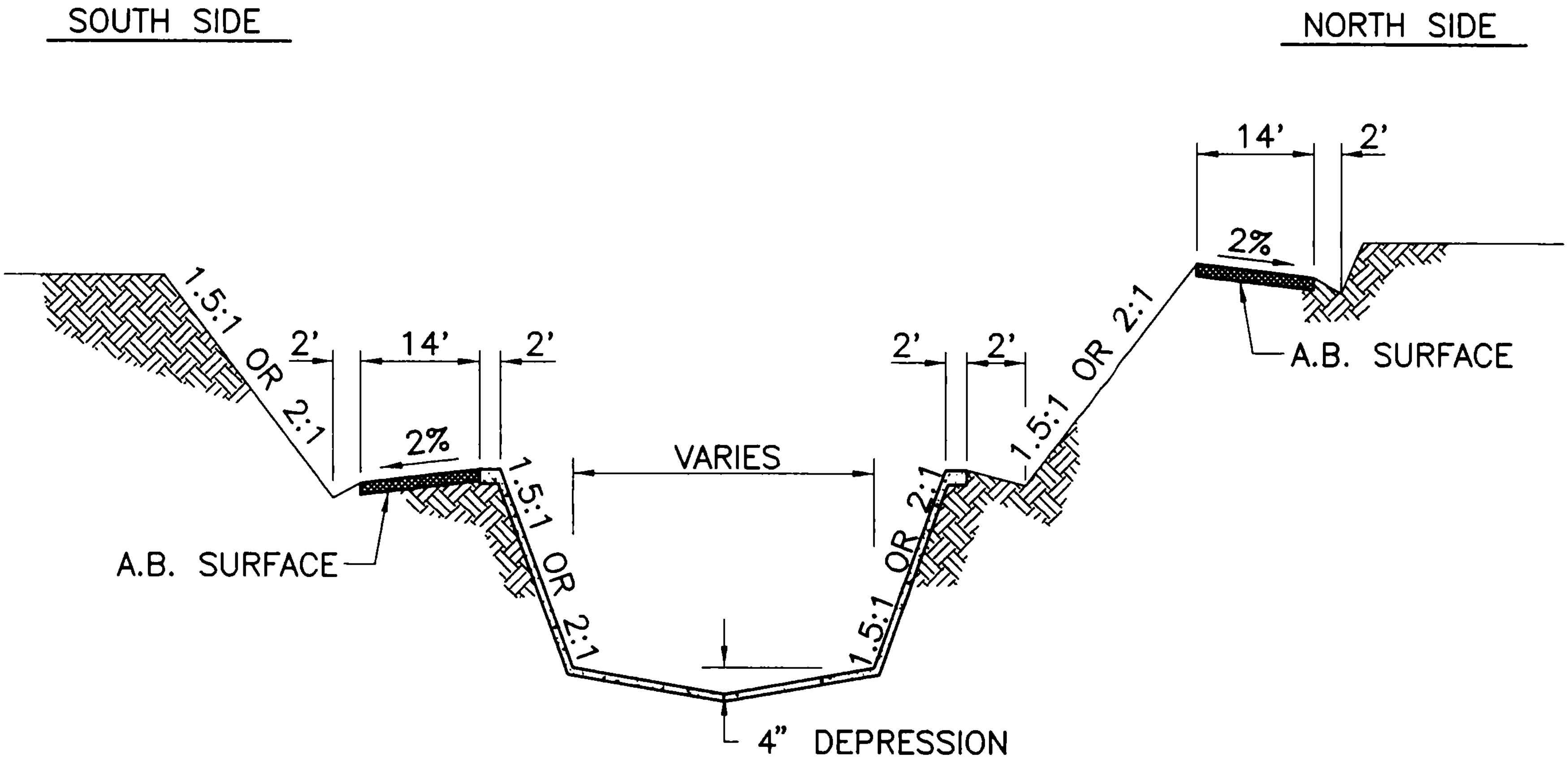
Surface flows reaching the channel at the top of lining enter the channel only at planned locations through concrete spillways. Flows over the top of liner at random locations and over long distances can develop flow patterns longitudinally at the top of the liner which can erode the material adjacent to the liner, undermining the liner which at a minimum is a maintenance problem and at worst can result in channel failure.

Channel Lining

The concrete channel lining is designed according to ADOT Channel Lining Design Guidelines, February 1989, the existing channel lining design, and the recommendations from the Report for Geotechnical Engineering Services, Dysart Drain Improvements Project, January 28, 1994 by Huntingdon Engineering and Environmental, Inc.

The following design features are utilized for concrete channel design:

1. The channel lining is continuously reinforced without expansion or tooled joints. Construction joints are provided at the end of a days pour or when concrete placement stops for more than 45 minutes. Reinforcing steel will be continuous through the joints.



TYPICAL CHANNEL SECTION

FIGURE 4

2. Reinforcing steel is placed longitudinally and transversely with a minimum 3 inches of concrete cover. Concrete is 6 inches thick with #4 reinforcing steel at 12 inch spacing both ways on the side slopes. Concrete is 8 inches thick with #4 bars laterally and #5 bars longitudinally at 12 inch spacing on the channel bottom.

3. Side slopes are 2:1 east of El Mirage due to sandy soil conditions and 1.5:1 west of El Mirage. The channel side slopes are flatter than the material angle of repose, therefore lateral earth pressures are not considered in the design.

4. Transverse cutoff walls are provided at the following locations:

   a. Where the lining abuts an existing concrete lining.
   b. At the upstream end of a transition section to widen the channel.
   c. Approximately every 1000 foot intervals along the channel.

5. Continuous 24-inch deep vertical cutoff walls are provided at the top of channel slopes 2 foot back of the top of slope.

6. The channel bottom lining has a cross slope toward the centerline of 4 inches to provide a means to transport sediment during low flows.

7. Invert access ramps are provided east and west of El Mirage Road, west of Dysart Road and at the end of the south maintenance access road near Litchfield Road.

8. A corrosion resistant concrete admixture is specified within the limits of the Morton Salt facility to protect the lining from potential adverse impacts from the salt environment caused by the Morton Salt activities.

Bedding and Underdrainage

In general, native in-place soils are adequate and will be used as a foundation for the concrete channel lining with the following exceptions in areas where special conditions exist:

1. Because the site contains an existing drainage structure (channel) and other improvements, special attention should be paid to locating and removing any subsurface remains of previous improvements. Such remnants should be removed and replaced with suitable material and compacted per the specifications.

2. Based on the geotechnical investigation, high plasticity clay soils exist between approximately stations 44+00 and 120+00 in the area of the finished channel invert. These high plasticity clays exhibit high potential for expansion when wetted. In areas where the high plasticity clays are found the channel will be overexcavated for two feet along the channel bottom and sideslopes and replaced with granular, free draining material.

3. The channel crosses an active earth fissure area on the east side of the Morton Salt facility. Active earth fissures are anticipated between stations 52+00 and 62+00. A testing program is specified to be conducted prior to channel excavation to positively identify any earth fissures. Earth fissures, if found, will be overexcavated to a depth and width of 3 feet on either side of the fissure. The open fissure beyond the excavation limits will be filled with aggregate base material. A PVC membrane will be placed in the bottom of the overexcavated area and backfilled with low plasticity, well compacted soil.

Underdrains are commonly used to relieve hydrostatic pressures from water accumulated adjacent to and beneath the channel lining. According to the geotechnical recommendations the potential for water accumulation is low for the Dysart Drain. Therefore, the use of special features for underdrainage such as weepholes or double liners are not utilized on this project.

6.4 Hydraulic Analysis

The Dysart Drain is analyzed using the U.S. Army Corps of Engineers HEC-2 Water Surface Profiles Computer Package. The as constructed condition is initially analyzed using the grades, elevations, and cross-sections shown on the construction plans. The profile is then adjusted based on the anticipated subsidence over a 40 year horizon and re-run to ensure adequate capacity for the subsided condition. The channel is designed to have capacity and freeboard for the 100-year discharge as constructed and capacity with no freeboard for the subsided condition. The water surface profile controlling the design varies throughout the reach.

Hydraulics of side spillways is analyzed using the broad crested weir equation to develop a stage discharge relationship for a range of flows up to the design 100-year discharge.

6.5 Agua Fria River Confluence

Starting Water Surface Elevation

The Agua Fria River was evaluated to determine impacts on the Dysart Drain hydraulics from a 100-year discharge in the Agua Fria River. Impacts from the Agua Fria River would be from backwater effects that would cause a rise in the water surface profile in the Dysart Drain. The 100-year discharge used for design is the post New-Waddell Dam flows.

The following sources, provided by the Flood Control District of Maricopa County were used in the evaluation.

> U.S. Army Corps of Engineers, Hydrology for Evaluation of Flood Reduction by New Waddell Dam, Agua Fria River below New Waddell Dam to the New River Confluence, Preliminary, September, 1988.
>
> Floodway Analysis, Agua Fria River F.I.S., HEC-2 input file, modified by CVL, August 1989. (On diskette).

The Corps of Engineers reports a 100 year peak discharge above the New River confluence of 30,000 cfs. The New River confluence is about two miles downstream from the Dysart Drain. Therefore, 30,000 cfs is adopted as the discharge to be used in the HEC-2 model for the post New Waddell Dam condition.

The Agua Fria River F.I.S. HEC-2 model was run with the selected Agua Fria discharge to determine the starting water surface elevation at the Dysart Drain. Interpolating between sections 11.80 and 11.89, the 100 year water surface is 1056.72. Although the Agua Fria River will cause ponding in the Dysart Drain if there is no flow in the

Drain, the Agua Fria water surface is low enough to cause no adverse backwater effects on the Dysart Drain during a 100 year discharge in the Dysart Drain.

404 Permit

It is the intent of the project to minimize impacts to "Waters of the U.S." at the Agua Fria River. The Corps of Engineers has delineated the jurisdictional area for 404 permit purposes. The limits of jurisdiction follow the Agua Fria River embankment at approximately elevation 1055 and extends up the Dysart Drain to the end sill of the existing outlet spillway structure.

The existing outlet spillway structure will be incorporated into the new design. The lining of the stilling basin will be extended and a grouted rock apron with a stilling basin drain will be constructed downstream from the basin. The grouted rock apron and the associated construction activity is the only work within waters of the U.S. at the Agua Fria River.

Waters of the U.S. have also been identified for a drainage located approximately 1100 feet west of El Mirage Road. Construction activity will be limited to the channel right of way and easements. The Flood Control District is coordinating with the Corps of Engineers to obtain required 404 permits.

6.6 Operation & Maintenance

Operation and maintenance features have been incorporated into the design to assist with long term maintenance requirements and access to the channel.

Operation and maintenance (O&M) roads are provided on both sides of the channel for most of the length of the project. As a minimum, an O&M road is provided on one side of the channel. In areas of deep cuts where the top of channel liner is well below natural ground, the O&M road on the south side is at the top of liner rather than the top of slope to provide better access for inspection and maintenance of the channel. In areas of deep cuts, reflectors are provided at the top of slope adjacent to the O&M road to assist maintenance personnel driving along the top of slope at night.

Invert access ramps are provided east and west of El Mirage Road, West of Dysart Road, and east of Litchfield Road. All ramps are oriented in the downstream direction except the one west of El Mirage Road which points upstream.

Fencing is provided around the entire project with gates at each point of access to the O&M roads.

7.0 DETENTION BASIN DESIGN

7.1 Design Criteria

The following design parameters have been used for detention basin design:

1. The maximum depth of water in the basin is to be approximately 10 feet.
2. The maximum berm and spoil area heights above the existing grade will be approximately 12 feet. The earthwork analysis suggests that an earthwork balance is feasible within the project site. This was pursued in order to reduce the significant cost impact of exporting the dirt.
3. Basin and berm sideslopes will have a maximum slope of 6:1. For the outlet channel, the side slope is kept to approximately 5:1. For the inlet and outlet structure transition area, where the side slopes are steeper than 2:1, grouted riprap linings are provided to enhance the slope stability.

Detention Basin Design

The grading design incorporates a positive slope in the basin bottom. The design was also refined by several iterations so that an optimum storage-outflow-volume relation was achieved.

Channel Velocities

All collector channels are lined with either gunite or grouted riprap lining to address erosion concerns. The outfall channel is provided with a gunite bottom, where the velocity is about 5 fps. The 5:1 sideslope area, however, has a velocity less than 2 fps, therefore, no erosion protection is warranted.

Channel Flow Conditions

Froude numbers for subcritical channel flow are to be less than or equal to 086. Froude numbers for supercritical flow are to be greater than or equal to 1.13 but less than 2.0. A minimum channel velocity of 2.0 feet per second is required to prevent deposition of fine sediments in the collector channels.

Channel Geometry

Changes in horizontal channel alignment for the collector channels are made with curves having a minimum radius of 3.0 times the water surface topwidth. According to the Hydraulics Manual, a minimum freeboard of 0.25 times the sum of the flow depth and velocity head is required, or a minimum of 1 foot for subcritical flow and 2 feet for supercritical flow, whichever is greater.

Exceptions to the minimum freeboard requirement have been approved by the District during the bi-weekly meeting dated December 6, 1993. Accordingly, the collector channels have been provided with 1 foot of freeboard. The outfall channel, however, will be provided with a minimum freeboard of 0.25 times the sum of the flow depth and velocity head.

7.2 Basin Inflow System

Design Inflows

Due to uncertainty in the split flow conditions, a conservative approach was utilized for the design of the collector channels within the detention basin. The peak flow that is established by WLB's November, 1993 report is used for design purposes. The inflow points and volume of peaks have been depicted on the attached **Figure 5.**

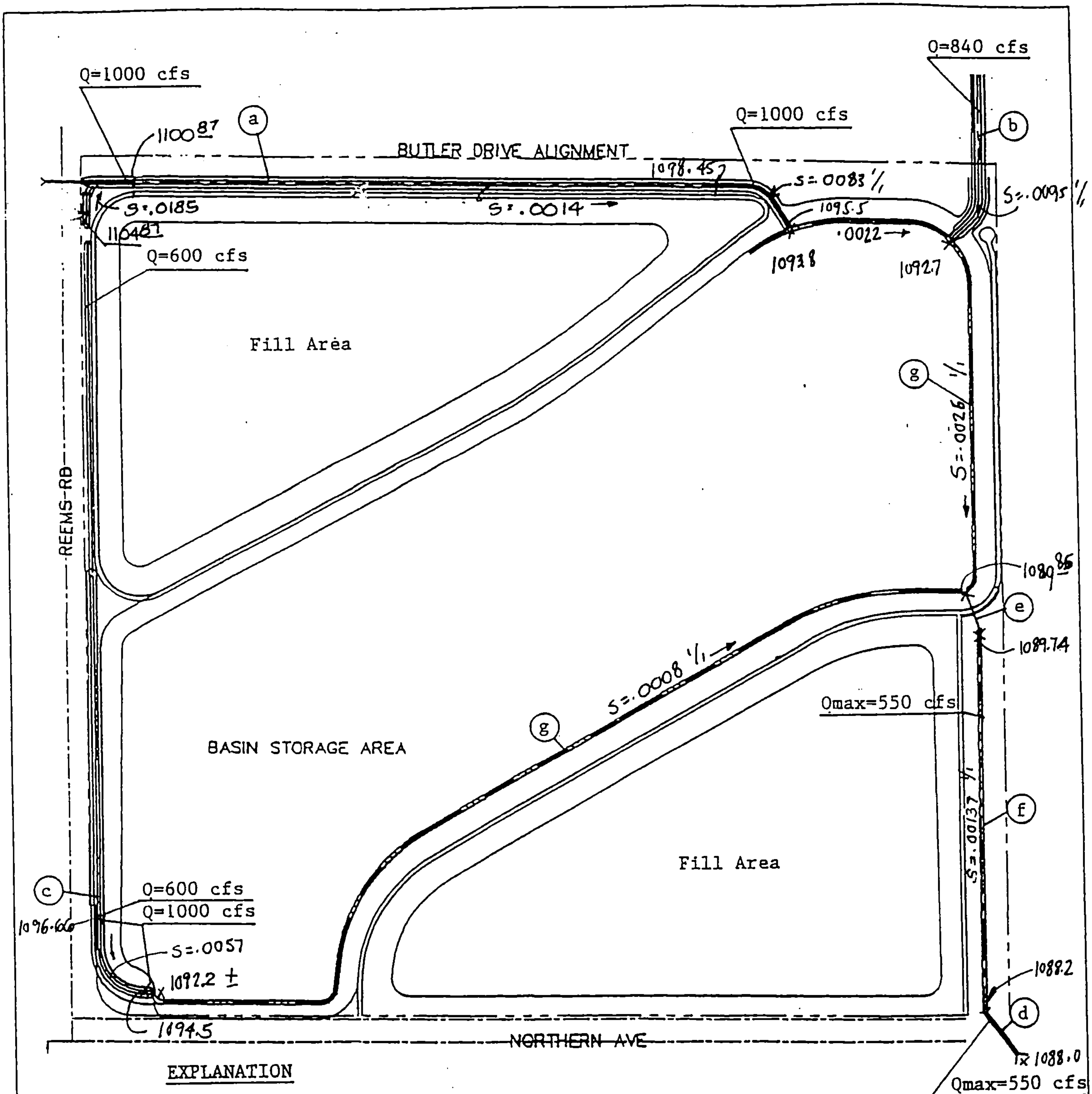
North Collector Channel

Flows will be collected in the current design via spillover from Reems Road into a collector channel approximately 214 feet in length along Reems Road. This channel will feed into a conveyance channel along the northern boundary (North Collector Channel). The channel will outfall into the detention basin as shown on the design plan.

Per the District's input, the North Collector Channel is designed in such a way that it can intercept design flow from the future box culvert across Reems Road. If for some reason the design flow value is increased from 1,000 cfs to 2,000 cfs, the proposed channel cross-section can be expanded. To account for this, flat ground area along the south side of the channel has been provided, so the south bank sideslope can be removed and additional cross-section can be added.

The North Collector Channel is a trapezoidal channel with 1.5:1 side slopes and a-12-foot bottom width. The lining of the lower 300 feet of the channel is composed of exposed rock grouted riprap; the remainder of the channel is concrete lined. At the basin inflow point, a grouted riprap apron is provided.

The North Collector Channel was analyzed using a HEC-2 model. The first cross-section of the model is located within the basin. The starting water surface elevation was set equal to the peak basin water surface elevation. The remaining cross-sections are located within the collector channel itself. A flow of 1,000 cfs was used for the entire length of the collector channel. A Manning's "n" value of 0.035 was used for the exposed rock grouted riprap-lined portion of the channel, and 0.014 was used for the concrete-lined portion.



EXPLANATION

- a North Collector Channel
- b East Collector Channel
- c Reems Road Collector Channel
- d Northern Avenue Box Culvert
- e Basin Outlet Box Culvert
- f Outfall Channel
- g Nuisance Flow Swale

PROPOSED CHANNEL GRADES DESIGN CONDITION

Scale 1"=400' ±

WOOD/PATEL ASSOCIATES
Civil Engineers
Hydrologists
Land Surveyors
(602) 234-1344

FIGURE 5

East Collector Channel

A new collector channel was designed along the mid-section line between Olive Avenue and the north basin boundary line.

As with the North Collector Channel, the East Collector Channel in the lower area near the north basin boundary is an exposed rock grouted-riprap-lined channel with a grouted riprap apron at the basin inflow point. The proposed channel has 2:1 side slopes and a 16-foot bottom width.

The East Collector Channel was analyzed using a HEC-2 model. The first cross-section of the model is located within the basin. The starting water surface elevation was set equal to the peak basin water surface elevation. A flow of 840 cfs was used for the exposed rock grouted riprap portion of the collector channel. A manning's "n" value of 0.035 was used for the exposed rock grouted riprap lining of the channel.

Reems Road Collector Channel

The Reems Road Collector Channel/swale system is located along the east side of Reems Road and extends from the southwest corner of the basin near Northern Avenue north for a distance of approximately 2,240 feet. The channel collects overflow from Reems Road and conveys it to the basin. The channel has a trapezoidal cross-section with a bottom width that varies from 20 feet near the basin inflow area to 10 feet further upstream as shown on the design plan. The channel lining consists of grouted riprap for the channel and soil cement for the side swale. As with the other collector channels, a grouted riprap apron is proposed at the basin inflow point.

This channel was also analyzed using a HEC-2 model. The first cross-section of the model is located within the basin. The starting water surface elevation was set equal to the peak basin water surface elevation. The remaining cross-sections are located within the collector channel itself. A flow of 1,000 cfs was used for the downstream 480 feet of channel; a flow of 600 cfs was used for the remainder of the side swale. The grouted riprap lining in this case is not an exposed rock lining as is the case with the other collector channels. Therefore, a lower Manning's "n" value of 0.030 is used for the grouted riprap lining of the Reems Road Collector Channel. A Manning's "n" value of 0.020 was used for the soil cement lining.

7.3 Storage Requirements

1. Maximum storage capacity for the basin is 550-acre feet. This volume includes detention volume, sediment volume, freeboard, and an allowance for other uncertainties in hydrology. These parameters have been established by the District.
2. The peak outflow of the detention basin will be 550 cfs and this will occur when the basin is completely full.

3. The subsidence values to be accounted for in the detention basin design are given by the District for all corners except the northeast corner. Wood/Patel has established an estimated value to be 12.4 feet of subsidence for the northeast corner. This value will be consistently used for design purposes.

7.4 Basin Outflow System

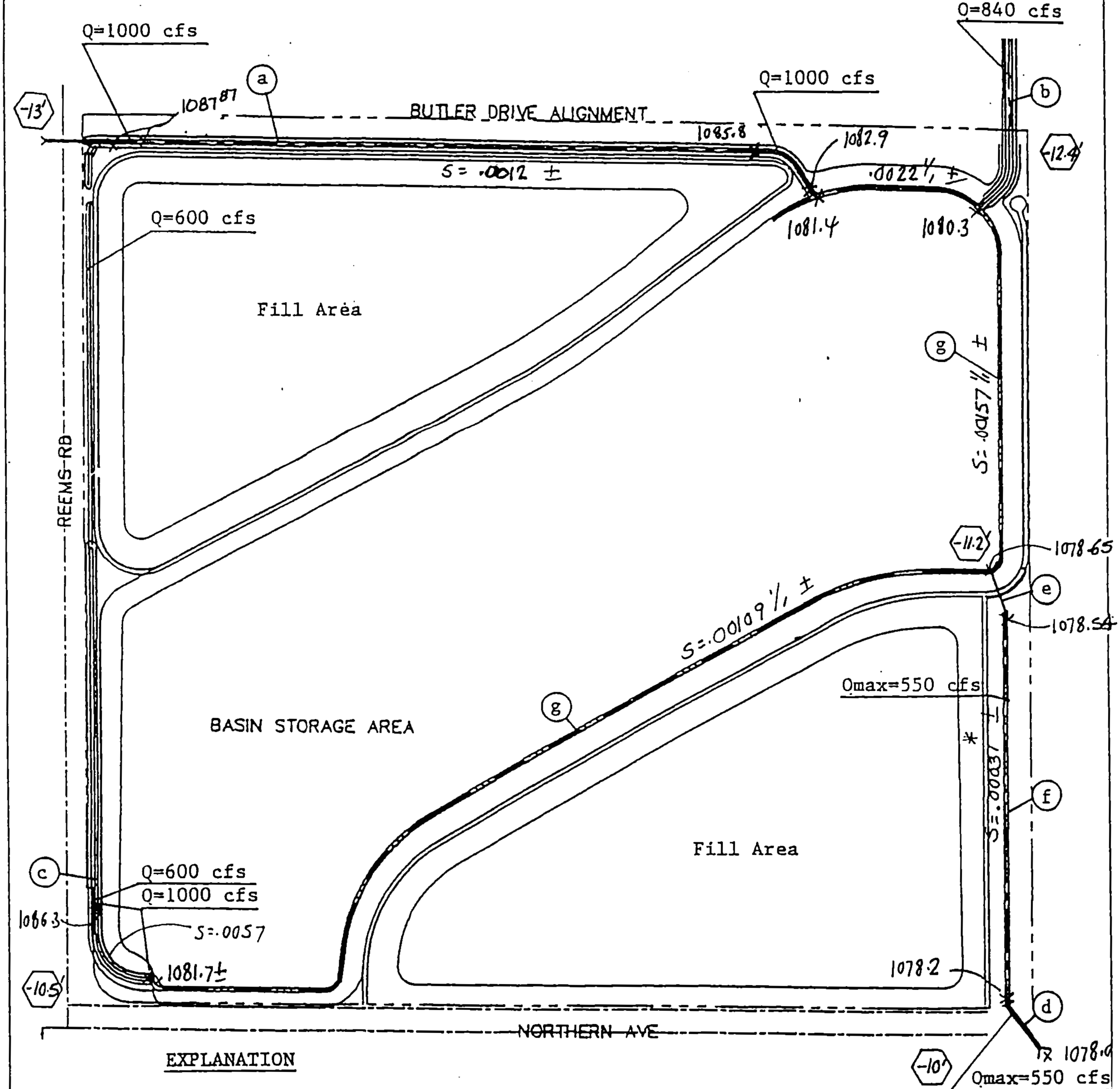
To achieve a nonjurisdictional embankment size, according to the Arizona Department of Water Resources, the basin configuration has been modified from the WLB concept. With the selected Option, the entire storage volume in the detention basin has been provided below natural grade. To achieve this, the outflow structure is now located approximately 1,300 feet north of Northern Avenue along the east boundary line. At Northern Avenue a 2-barrel 6' x 6' box culvert is provided. A gunite bottom channel will be provided between Northern Avenue to the outflow box culvert. This will enhance nuisance flow conveyance for the drainage outflow. It will also reduce the potential of any ponding or added maintenance. This was essential because the gradient along this channel is very flat. This channel was also checked for a positive drainage condition in the case of future subsidence.

As discussed in the paragraph above, the entire storage volume is provided in the basin below the natural grade. In a case where the basin is completely full and all freeboard volume has been used, the spillover will occur over the natural grade at the southeast corner near Northern Avenue.

To ensure functioning of the outfall box culvert, a HEC-2 analysis was performed, beginning from the Northern Avenue Channel to the proposed 1-barrel 6' x 7' basin outlet box culvert through the outfall channel. The HEC-2 analysis was utilized to create an outflow rating curve for the outfall structure.

Starting conditions for the HEC-2 model were obtained by using a normal-depth rating curve for the Northern Avenue Channel. This rating curve was then used as a tailwater condition for the 2-barrel 6' X 6' box culvert at Northern Avenue. Culvert headwater calculations were then performed for several different flows in order to obtain starting water surface elevations for the basin outflow channel HEC-2 model.

The above methodology was repeated for the future condition, in which elevations were lowered to account for subsidence. For the outfall channel, the proposed channel grades are depicted on Figure 3 and the subsided channel grades are depicted on **Figure 6**.



EXPLANATION

- a North Collector Channel
- b East Collector Channel
- c Reems Road Collector Channel
- d Northern Avenue Box Culvert
- e Basin Outlet Box Culvert
- f Outfall Channel
- g Nuisance Flow Swale
- (-11) Projected Subsidence
- * Critical Area for Channel Slope

PROPOSED CHANNEL GRADES
SUBSIDENCE CONDITION

WOOD/PATEL ASSOCIATES
Civil Engineers
Hydrologists
Land Surveyors
(602) 234-1344

Scale 1"=400' ±

FIGURE 6

SUMMARY OF CHANNEL SLOPES (FT/FT)

Drainage Feature	Design Condition	Subsided Condition	Remark
a North Collector Channel	.0014	.0012	OK
b East Collector Channel	.0095	.0095	OK
c Reems Road Collector Channel	.0057	.0057	OK
f Outfall Channel	.00137	.00031	Check For Conveyance
g Nuisance Flow Channel - East Nuisance Flow Channel - South	.0026 .0008	.00157 .00109	OK OK

As can be seen from the above summary, all major drainage features will have a minor impact for the subsided condition with the exception of the outfall channel. To address adequate functioning of the outfall channel, a detailed backwater analysis was performed and is included in this report.

7.5 Operation & Maintenance

To reduce the amount of nuisance ponding, all major inflows will be directed into nuisance flow swales, which run along the south and east side of the detention basin bottom. These swales, with a bottom width of 10 feet and an approximate depth of 2 feet, have the capacity to handle approximately a 100 cfs flow. Flows of 100 cfs can be anticipated from a storm in about a 1-year event. Any irrigation runoff which will end up in the detention basin, will also be handled by these swales. The swales will help reduce the sediment deposition problem, nuisance flow collection problem, growth introduced by nuisance flow, and bird population which may be attracted as a result of vegetation and ponding.

Operation and Maintenance Feature Design

1. A 14-foot stabilized maintenance access road is provided around the basin with access to Reems Road and Northern Avenue.
2. An invert access ramp from the maintenance access road is provided into the basin from the north side.

3. A four strand, plain wire fence has been placed around the basin boundary. Two access gates have been provided on Northern Avenue and one each at the north end of Reems Road and at the east end of the farm road.

4. A 1-foot to 2-foot high dike to divert onsite runoff will be provided on the top of fill areas along the lowest elevation near the edges. The concentrated flows will be collected at the outfall point and discharged into the north collector channel or outfall channel via storm drain.

Farmer's Requirements

1. The existing irrigation ditch, located along the north property line, will not be disturbed. Therefore, the right-of-way has been established a minimum of 55 feet south of the mid-section line in accordance with District requirements.

2. The existing waterline, which pumps tailwater from the ponding area near Northern Avenue, will be relocated along the east boundary of the basin.

3. All irrigation and other structures located within the basin boundary will be removed or abandoned. All channels within the MCDOT right-of-way along Northern Avenue will be filled to the natural grade. All drainage culverts within that right-of-way also will be removed.

8.0 STRUCTURE DESIGN

Bridge structures are provided at Dysart Road, El Mirage Road, and at the Morton Salt Facility. Each of the bridges will consist of a single span superstructure with standard AASHTO precast prestressed concrete girders with cast-in-place concrete bridge deck and cast-in-place abutments and wingwalls. The abutments will be supported on drilled shafts. The use of drilled shaft foundations is based on geotechnical recommendations by Huntingdon Engineering and Environmental, Inc.

The Dysart Road bridge has a span length of 71'-0" and an 84'-0" deck width which includes 8'-0" sidewalks with handrail and barrier at each side of the bridge. The deck is crowned with a nominal cross slope of 2 percent. Standard approach slabs are provided at each end of the bridge.

The El Mirage Road bridge has a span length of 71'-0" and an 84'-0" deck width which includes 8'-0" sidewalks with handrail and barrier at each side of the bridge. The deck is crowned with a nominal cross slope of 2 percent. Standard approach slabs are provided at each end of the bridge.

The Morton Salt Facility bridge has a span length of 71'-0" and a 25'-0" deck width with no sidewalks. A pedestrian rail fence 3'- 6" high is used. Approach slabs will not be provided. The Morton Salt staff have also requested several measures be incorporated into the design of the bridge to reduce the damaging effects of the high concentrations of salt on the bridge from facility operations and as otherwise specified. These measures are:

(1) The structure deck is sloped to drain properly and prevent ponding of salt laden water.

(2) Powder (fusion bonded) coated rebar is specified in the deck and curb.

(3) Air entrained concrete will be used. The percent of entrained air will be between 4% and 6% by volume.

(4) The deck thickness and cover over the upper layer of reinforcing is increased by two inches, for a total cover to reinforcing of 4.5 inches. This request is intended to provide a sacrificial wearing surface for tracked vehicles crossing the bridge. There will be no additional allowance for future wearing surface, since additional cover is incorporated during initial construction.

(5) Aggregate with no iron content is specified. The specification for this will be provided by Morton Salt for inclusion in the Special Provisions.

(6) The design loading will be at least adequate for a two axle vehicle with a gross weight of 45,000 pounds.

9.0 CONSTRUCTION CONSIDERATIONS

9.1 Sequence

The project will be constructed under three construction contracts; The Detention Basin and Collector Channels, The Bridges and Utility Crossings, and the Channel Improvements. The Detention Basin and Collector Channels and the Bridges and Utility Crossings will be completed simultaneously and the Channel Improvements will be completed following completion of the other two. The following general sequence of work will be followed for each project. The items are numbered to indicate concurrent items and items that must be done in sequence. The general sequence will be I, II, III, and IV. Items IIIA and IIIB, and IVA and IVB can be performed simultaneously. The work under each item may be done according to the numbering sequence under that item. Multiple tasks under each number can be done simultaneously.

Bridges and Utility Crossings

IA. Remove and Replace El Mirage Road and Morton Salt bridges.

IB. Construct new utility carrier pipes.

II. Remove and Replace Dysart Road bridge.

III. Clean up and finalize.

Detention Basin and Collector Channels

I. Irrigation and Utility Relocations

II. Detention basin grading.

IIIA. Construct basin outlet box culvert.

IIIB. Construct basin collector and outlet channels.

IVA. Reconstruct Reems Road and tie into basin.

IVB. Right of way fences and gates.

V. Clean up and finalize.

Channel Improvements

I. Irrigation and utility relocations.

II. Channel construction - Agua Fria River to Dysart Road.

III. Channel construction - Dysart Road to east of Litchfield Road.

IV. Channel construction on base.

1. Channel lining extension.
2. New railroad box & channel adjacent to long box.
3. Long box to basin outlet.

VA. Northern Avenue Construction

VB. Miscellaneous Construction

1. Cut slope treatment.
   O&M road construction
2. ROW fence and gates.

VI. Clean up and finalize

9.2 Schedule

Tentative construction schedules are shown for each project on **Figures 7, 8, and 9.**

9.3 Management of Nuisance Flows

The recommended approach to handling nuisance flows is to construct the channel in segments approximately one mile in length progressing from the Agua Fria River in an upstream direction and divert nuisance flows around the segment being constructed as follows:

1. Construct a temporary berm across the channel at the upstream end of the segment to block nuisance flows.

2. Pump collected nuisance flows around construction in a pipe, hose, or diversion ditch. The flow can be discharged on the downstream side of the segment under construction. The specifications will indicate the maximum discharge that must be accomodated.

3. The channel will be maintained in operating condition outside the segment being constructed until the segment is complete and ready to accept flows from the next upstream segment.

Logical segments would be 1) Agua Fria River to Dysart Road, 2) Dysart Road to E. of Litchfield Road, 3) Railroad box and channel around long box, and 4) Long box to detention basin outlet.

For the detention basin it is recommended that the existing flow patterns be maintained during grading of the basin and construction of the collector and outlet channels and the box culverts. Nuisance flows will continue to flow down Reems Road and in the existing channel along the north side of Northern Avenue into the Dysart Drain at Luke Air Force Base. Upon completion of the Reems Road improvements and associated basin inlet structures, runoff will be directed into the basin. In the interim period between completion of the detention basin and completion of the downstream channel improvements, the basin will drain through the outlet channel and the existing CMP and dip crossing at Northern Ave. During Northern Avenue construction, the detention basin outlet will be plugged and nuisance flows retained within the basin. upon completion of the Northern Avenue improvements and the outlet channel, the plug will be removed, completing the system.

FCD93-01 DYSART DRAIN IMPROVEMENTS PROJECT

CONSTRUCTION SCHEDULE

BRIDGES & UTILITY CROSSINGS

Task No.	*Major Tasks*	Months																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
IA.	*R&R El Mirage & Morton Bridges*	■	■	■	■														
IB.	*Constr. Utility Carrier Pipes*	■	■																
II.	*R&R Dysart Road Bridge*					■	■	■	■										
III.	*Clean-up & Finalize*									■									

FIGURE 7

FCD93-01 DYSART DRAIN IMPROVEMENTS PROJECT

CONSTRUCTION SCHEDULE

DETENTION BASIN AND COLLECTOR CHANNELS

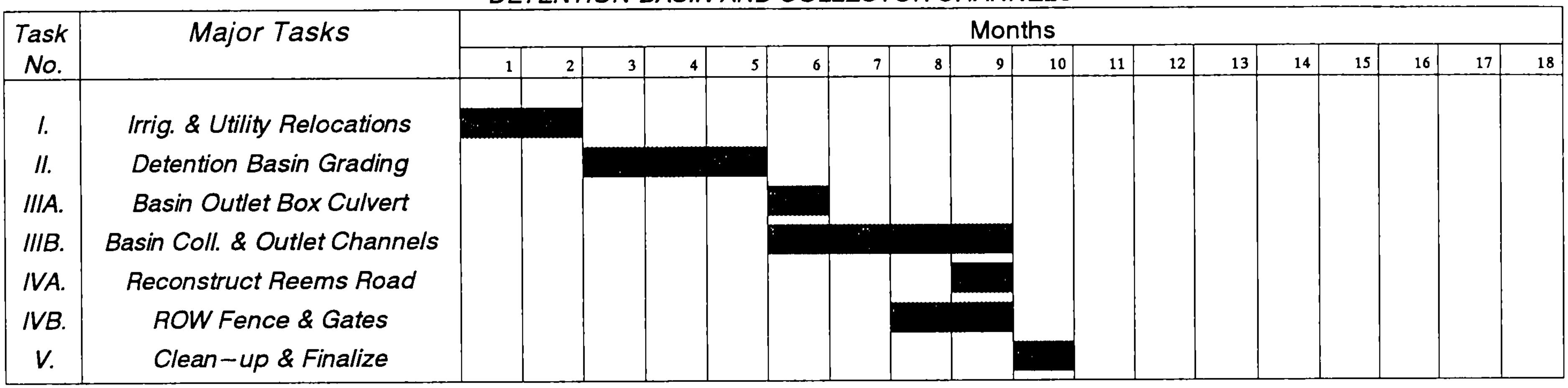


FIGURE 8

FCD93-01 DYSART DRAIN IMPROVEMENTS PROJECT

CONSTRUCTION SCHEDULE

CHANNEL IMPROVEMENTS

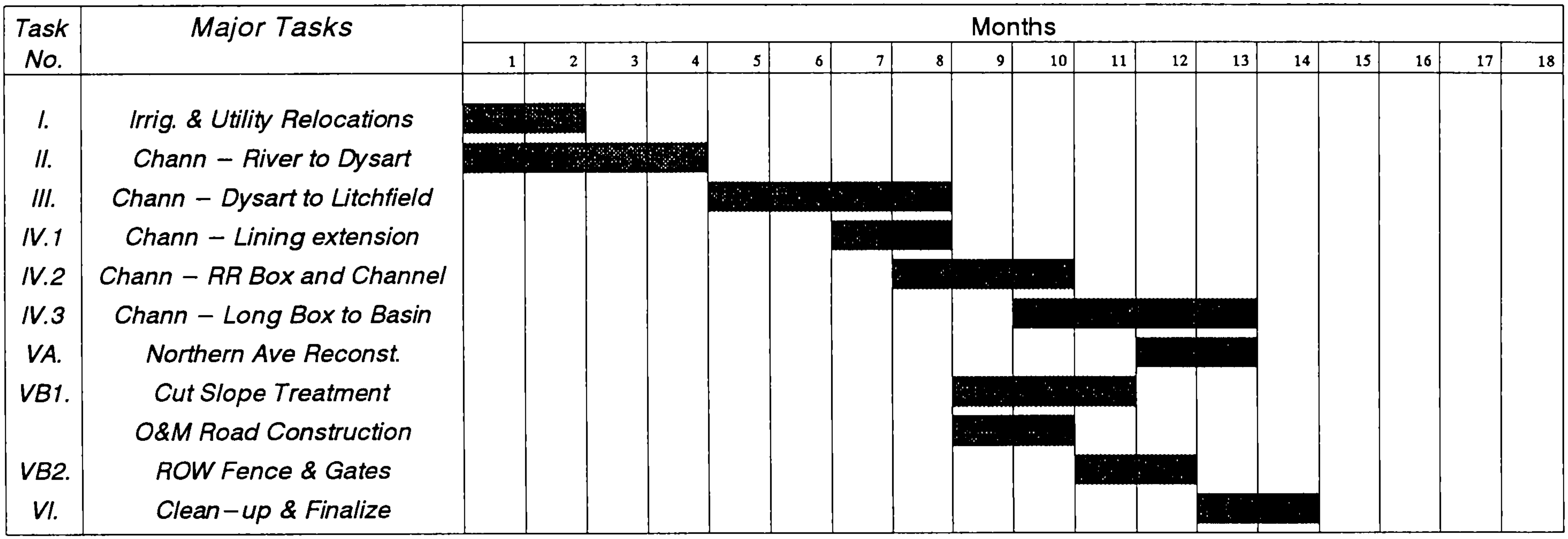


FIGURE 9

10.0 REFERENCES

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